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ABSTRACT

In the last 20 years the U.S. economy had changed as a result of the increase in production, processing, and distribution of information goods and services. Three information sectors--the primary sector producing information goods and services, the private bureaucracy, and the public bureaucracy--are part of a six-sector economy. Today, information activity represents about 50% of the GNP (Gross National Product), and much evidence exists to support the contention that our economy is planned. So that planning can be productive and efficient, resources need to be allocated in different ways among the several sectors of the economy. (CH)

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THE INFORMATION SECTOR: DEFINITION & MEASUREMENT

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INTRODUCTION

We are now an information economy. Over half of our wage bill and some 45% of GNP originates in the production, processing or distribution of information goods and services. This paper addresses a failure in self-perception. We have not yet, at a national policy level, fully recognized how forcefully and irrevocably our economy has changed in the last twenty years. I shall attempt to describe in detail how the informational components of GNP were assembled and accounted, and how the economy as a whole is conceptualized.

Some 15 years ago, Machlup took us on a "magnificent" guided tour of a major sector of the economy" -- the knowledge producing and distributing industries.¹ He estimated that total knowledge production in 1958 was almost 29 percent of GNP, and that knowledge-producing occupations accounted for about 31% of the U.S. workforce.

Machlup also estimated the knowledge industries expanded at a compound growth rate of 10.6 percent per year between 1947-1958 -- doubling in less than 4 years. His

¹Fritz Machlup, The Production and Distribution of Knowledge in the United States, Princeton University Press, Princeton, New Jersey, 1962. The quote is attributed to Kenneth E. Boulding, who has also written extensively on the knowledge industries.

seminal work, which lead to subsequent books by Bell², Drucker³, and others, provides the conceptual underpinnings for this paper.

Bell introduced the concept of a "post-industrial society" in which services eclipse agriculture and manufacturing as a source of national wealth. For Bell, the key axial principles of a post-industries society are the emergency of knowledge, information and planning as pre-eminent activities. Drucker emphasized the importance of knowledge and information in the modern organization's arsenal.

An economy can be separated into two domains. The first is involved in the transformation of matter and energy from one form into another. The second is involved in transforming information from one pattern into another. The two domains are linked and unseparable. Manipulation of matter and energy would be impossible without a sizable input of knowledge, planning, coordination and control information. And the production, processing and distribution of information would be impossible

²Daniel Bell, The Coming of Post Industrial Society, Basic Books, New York, 1973. The concept of the service sector was first introduced by Colin Clark (Conditions of Economic Progress) in 1940, and expanded in Victor Ficht's contributions on The Service Economy (NBER, 1968).

³Peter Drucker, The Age of Discontinuity, Pan Books Ltd., London.

without a sizable input of matter and energy. The systematic marriage of these two domains is absolute. The question is the relative contribution of each partner in producing economic wealth. Parker⁴ and Oettinger⁵ were instrumental in providing the organizing principle. In this paper, the two domains are described and measured, and their structural relationship is examined.

The infrastructure of an information economy is the panoply of new information machines and services -- computers, telecommunications networks, satellites, cable television systems, communication hardware, information "utilities" and the like. The superstructure of an information economy are the huge public and private bureaucracies. I shall be describing the dimension of the bureaucracies -- their size and location within the economy. In particular, the Federal Government is conceived as an "information industry," and its inputs and outputs are measured.

⁴Edwin B. Parker. See generally, "Social Implications of Computer/Telecommunications Systems", Center for Interdisciplinary Research, Stanford University. Report No. 16.

⁵Anthony Oettinger, "Information Industries in the United States", Britannica Book of the Year, 1975. Oettinger summarizes the argument with the following aphorism: "Without matter there is nothing; without energy, matter is inert; and without information, matter and energy are disorganized, hence useless."

The Office of Telecommunications (Commerce), under a grant from the National Science Foundation (RANN/Division of Advanced Productivity Research and Technology) is presently conducting a study of the information sector. The work is aimed at (1) formally introducing a definition and measurement of a sector which is consistent with the National Income accounts, and (2) investigating the structure of the information economy using Input-Output techniques.

THE INFORMATION WORKERS

In the traditional sense of the word, "industry" was a person's work or craft. Agricultural societies are characterized by a workforce whose largest segment works in farms; similarly, an industrial society is one where the largest group works in factories or skilled crafts types of occupations. The largest group in the U.S. workforce is now involved in a variety of informational occupations -- jobs whose major feature is producing, processing or distributing symbols.

The Bureau of Labor Statistics provides an Occupation by Industry matrix showing the location of 440 different occupational groups within 200 industries. I have converted this detailed information on the U.S. occupational structure into a matrix of employees compensation. This new matrix shows the precise wage bill paid by each industry for all types of workers. The following data come from that matrix, and a look at the Census of Populations dating back to 1860.

The 400 occupations were organized into five major classes and thirteen groups. Table 1 shows the conceptual scheme (detailed occupations are omitted) and the employee compensation paid to each class in 1967. Our information workforce earned \$234,106 in 1967. This represents about 51% of the total wage bill and about 30% of value added (GNP).

TABLE 1: 1967 INFORMATION WORKERS' COMPENSATION *

MARKETS FOR INFORMATION

\$ million

10	KNOWLEDGE PRODUCERS	<u>46,964</u>
100	Scientific and Technical Workers	18,777
110	Private Information Services	28,187
20	INFORMATION DISTRIBUTORS	<u>28,265</u>
200	Educators	23,680
210	Public Information Disseminators	1,264
220	Communication Workers	3,321

INFORMATION IN MARKETS

30	MARKET SEARCH AND COORDINATION SPECIALISTS	<u>93,370</u>
300	Information Gatherers	6,132
310	Search and Coordination Specialists	28,252
320	Planning and Control Workers	58,986
40	<u>INFORMATION PROCESSORS</u>	<u>61,340</u>
400	Non-Electronic Based	34,317
410	Electronic Based	27,023

INFORMATION INFRASTRUCTURE

50	INFORMATION MACHINE WORKERS	<u>13,167</u>
500	Non-Electronic Machine Operators	4,219
510	Electronic Machine Operators	3,660
520	Telecommunication Workers	5,288

TOTAL INFORMATION 243,106

TOTAL EMPLOYEE COMPENSATION 454,259 **

INFORMATION AS % OF TOTAL 53.52%

* Employee compensation includes wages and salaries and supplements.

** Excluding military workers.

The change in the workforce did not happen suddenly. The trend towards information and away from other types of occupations has been persistent since the turn of the century. Figure 1 shows a time series on the U.S. workforce split into two groups: information workers and all other workers. Because of definitional ambiguities, we computed the chart using both restrictive and inclusive definitions. Depending on one's definition, information workers represented over 50% of the workforce between 1976 and 1980.

Figure 2 shows a four sector aggregation of the U.S. workforce: agriculture, industry, services and information. The chart clearly shows the transformation of the U.S. through three distinct stages.

In Stage I (1776 - 1906), the largest single group in the labor force was in agriculture. By the turn of the century, industrial occupations began to grow rapidly, and became predominant during Stage II (1906 - 1954). In the current period, Stage III, information occupations comprise the largest group.

We now leave this very brief description of the information sector in labor and move to an industry view where the composition of GNP is analyzed in detail.

% OF
TOTAL WORKFORCE

100

90

80

70

60

50

40

30

20

10

Figure 1

TIME SERIES OF U.S. LABOR FORCE
(1860 - 1980)

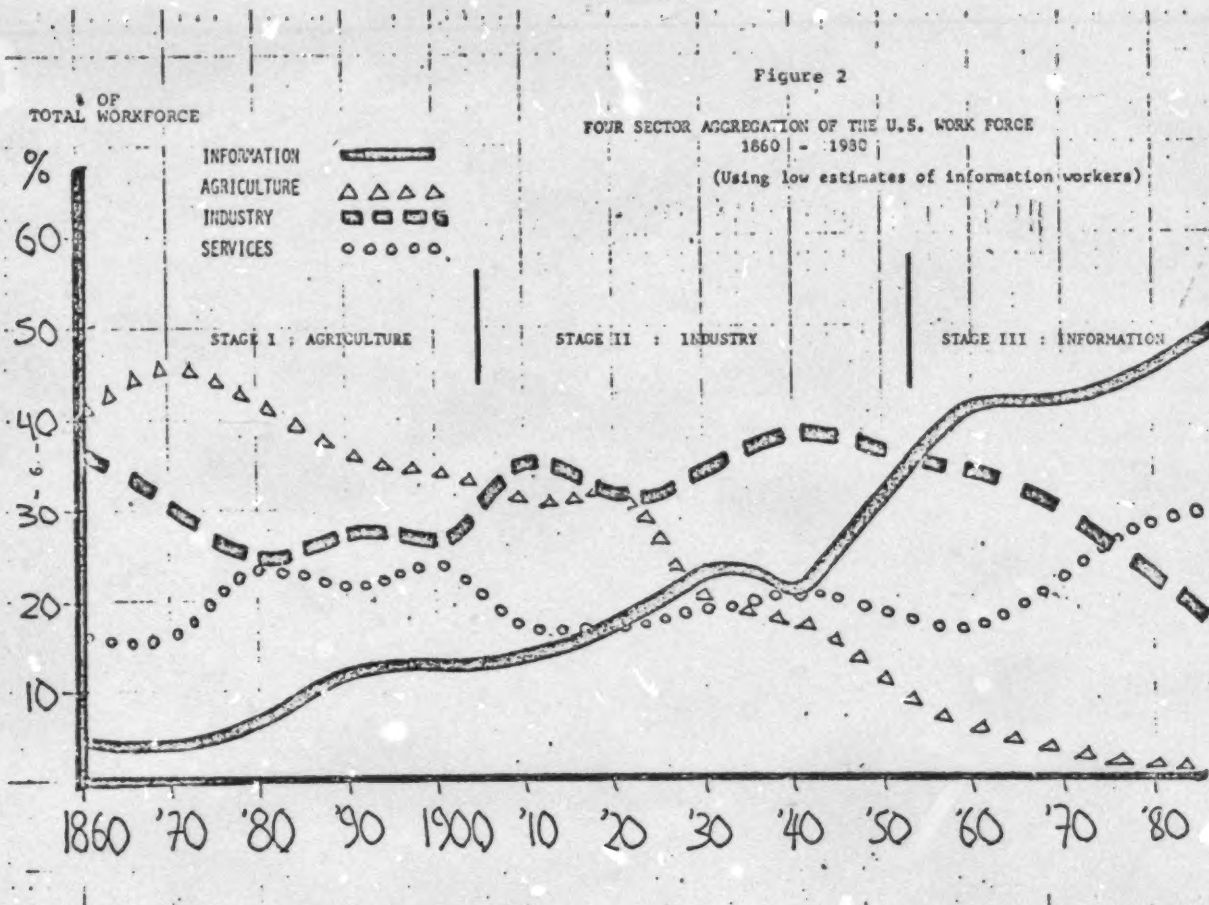
TWO SECTOR AGGREGATE

NON-INFORMATION
WORKERS

INFORMATION
WORKERS

CROSS-OVER
REGION

1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980



THE INFORMATION ACTIVITY

Information is by its nature a heterogeneous commodity, and the collection of industries which sell information goods and services are equally heterogeneous. Information cannot be collapsed into one sector -- like agriculture -- but rather the production, processing and distribution of information goods and services should be thought of as an activity.

One way of motivating the conceptual scheme that underlies our definitions and measurements is to think of the "food activity" in the economy. The provision of food involves a variety of heterogeneous industries: the farm, the trucking firm, the wholesaler, the food processor, the grocery store, the restaurant, and the manufacturer of stoves and refrigerators. Similarly, the provision of information is an activity that involves a large number of interrelated industries: education, the communications media, advertising, business consulting, brokerage industries, and manufacturers of "information machines" such as computers, telephones and television sets.

The information activity includes three distinct sectors. The primary sector includes those industries which sell information goods and services to intermediate demand (other firms) and final demand (consumers, governments, gross capital formation and net export). Their primary product, an information good or service, is transacted in a marketplace. This market basket of information machines and services is sold mostly to the other two sectors of the information activity -- the private bureaucracy and the public bureaucracy. These two sectors comprise the planning, coordinating, inquiring, communicating, analyzing and deciding activities of a non-market nature. The private bureaucracy resides within firms, hence its output is never transacted on a marketplace; the public bureaucracy includes

the informational portion of federal, state and local governments, and it too is shielded from market pressures. As we shall see, the planning sector of our economy is very large indeed.

The three sectors of the information economy together accounted for over 45 percent of Gross National Product in 1967. The remaining 55 percent of GNP originated in the non-informational sector of the economy. This domain covers agriculture, mining, most durable and non-durable goods manufacturing, the bulk of retail and wholesale trade, transportation services, personal services, utilities and the non-informational parts of government such as dam-building and national defense.

This paper is a summary of a more detailed accounting of the three information sectors.⁶ We shall take a close look at the composition of GNP in the three sectors, and present an Input-Output scheme that organizes the economy using a simplified six-sector scheme.

⁶See Porat, The Information Economy, (forthcoming dissertation), Stanford University, 1976.

THE PRIMARY INFORMATION SECTOR

Machlup's taxonomy of knowledge producing and distributing industries included: (i) education, (ii) research and development, (iii) the media of communication, (iv) information machines, and (v) information services. These five classes of goods and services are generally included in the primary information sector.

The hundreds of goods and services in the primary information sector are conceptually organized into the seven categories of Table 2. The different classes of information goods and services were chosen with a theoretical scheme in mind⁷ that divided information into categories that are meaningful from a theoretical or policy-making point of view. For example, "Knowledge production and inventive industries" raises the theoretical issues of information as a market commodity, especially as a public good. "Search and coordination industries" raise the problems of information in markets, where the behavior of markets under different degrees of imperfect information is examined.

A more conventional way of describing the primary information sector is by simply listing the industries involved and showing their share of GNP. Table 3 gives an overview of the primary information sector. The thousands

⁷ Porat, "The Information Economy and the Economics... of Information," Stanford University, 1976.

TABLE 2: TYPES OF INFORMATION GOODS AND SERVICES INDUSTRIES

1. Knowledge Production and Inventive Industries
 - R&D and inventive industries
 - Private information services (legal, architectural, business consulting, accounting, counselling, etc.)
2. Information Distribution and Communication Industries
 - Education
 - Public information services (e.g., libraries)
 - Regulated communication media (e.g., television, radio, telephone)
 - Unregulated communication media (e.g., film, newspaper, publishing)
 - Retail distribution of information goods (e.g., newsstands, TV stores)
3. Search and Coordination Industries
 - Search industries (employment agencies, non-speculative brokers, credit agencies, title abstract companies)
 - Advertising industries (e.g., advertising agencies, direct mail)
 - Non-market coordinating institutions (e.g., business associations, professional associations, labor unions, political organizations)
4. Risk Management
 - Components of insurance industries (e.g., diagnostic, actuarial, processing functions)
 - Components of finance industries (e.g., analytical, clerical transactions processing)
 - Speculative brokers (e.g., security and commodity, patent owners and lessors)
5. Information Infrastructure
 - Non-electronic based processing (e.g., printing photography, blueprints)
 - Electronic-based processing (e.g., data processing, xerography)
 - Telecommunications (e.g., telephone, data networks, satellite)
6. Information Goods Manufacturing Industries
 - Non-electronic consumption or intermediate goods (e.g., paper, ink, pens, pencils, photographic supplies)
 - Non-electronic investment goods (e.g., typewriters, printing presses, office machines, mechanical calculators, scales)
 - Electronic consumption or intermediate goods (e.g., television sets, semiconductors, calculators)
 - Electronic investment goods (e.g., computers, instrumentation, satellites, communication equipment)
7. Support Facilities
 - School buildings, telephone and telegraph facilities, office buildings: construction, repair and maintenance, furnishing and rental.

TABLE 3: OVERVIEW OF THE PRIMARY INFORMATION SECTOR

(\$ Million 1967)				
CONVENTIONAL * SECTOR OF ORIGINATION	INFO FINAL DEMAND	% TOTAL FINAL DEMAND	INFO VALUE ADDED	% TOTAL VALUE ADDED
AGRICULTURE	0	0	0	0
MINING	0	0	0	0
CONSTRUCTION	13,263	1.67	10,107	1.26
MFRG: NON-DUR	7,248	0.91	12,596	1.58
MFRG: DURABLE	26,908	3.38	20,987	2.64
SERVICES	84,200	10.59	118,934	14.95
TOTAL	131,619	16.55	162,624	20.45

* Includes only information industries which usually appear under the broad non-information sector designation, e.g., computers as a portion of the durable goods manufacturing sector.

of goods and services that are summarized in the detail Table 4 show the sector of origination in the standard National Income and Product Accounts. For example, "printing" appears in the Non-Durable Manufacturing sector of the accounts; hence, the \$7.2 billion in sales to final demand shown by the non-durable manufacturing sector in Table 3 contains just the informational elements of the printing industry.

We are now producing a time series of the primary information sector covering the period 1929-1972. It should be ready sometime in May.

THE TWO PLANNING SECTORS

The other two information sectors are the heart of the modern post-industrial economy. They are the huge bureaucracies in the private economy and in the government -- the corporate headquarters, the Executive agencies, the decision-making towers downtown, the acres of government office buildings, the R&D labs and the computer centers within industry. These private and public planning centers are staffed by an army of secretaries, clerks, managers and lawyers. They are equipped with truckloads of typewriters, computers, microwave and telecommunication gear.

TABLE 4 : DETAIL OF PRIMARY INFORMATION SECTOR, (\$ Millions 1967)

Selected Components From:	Sales to Final Demand (Product)	Value Added (Income)	Value Added as % of GNP
<u>TOTAL INFORMATION</u>	<u>131,619</u>	<u>162,624</u>	<u>20.45</u>
<u>Information Services</u>			
Communications, exc. radio & TV	10,080	16,029	2.02
Radio & TV Broadcasting	7	1,580	0.20
Wholesale & Retail Trade	16,273	16,403	2.06
Finance and Insurance	20,652	23,003	2.89
Banking	6,328	9,574	
Credit Agencies	1,913	- 145	
Security & Commodity Brokers	2,257	2,779	
Insurance Carriers	9,554	7,310	
Insurance Agents & Brokers	0	3,485	
Real Estate & Rental	3,714	15,392	1.94
Hotels, Personal & Repair Service	1,414	853	0.11
Business Services	7,750	22,878	2.88
Miscellaneous Business Svc.	2,982	9,101	
Advertising	205	1,594	
Miscellaneous Professional	4,563	12,183	
Amusements	1,783	2,009	0.25
Medical, Educational & Non-Profit	22,564	17,147	2.16
Doctors Offices	6,829	5,394	
Other Medical & Health	34	234	
Educational Services	7,957	5,170	
Non-Profit Organizations	7,744	6,349	
Federal Government Enterprises	1,581	3,640	0.46
<u>TOTAL INFORMATION SERVICES</u>	<u>85,818</u>	<u>118,934</u>	<u>14.95</u>
<u>Manufacturing: Non-Durable Information Goods</u>			
Paper & Allied Products	768	1,780	0.22
Printing & Publishing	5,493	10,481	1.32
Miscellaneous Manufacturing	510	335	0.04
Office Supplies	470	---	
<u>TOTAL MANUFACTURING NON-DURABLE INFORMATION GOODS</u>	<u>7,248</u>	<u>12,596</u>	<u>1.58</u>
<u>Manufacturing: Durable Information Goods</u>			
Other Furniture & Fixtures (Offices)	1,000	1,273	0.16
Special Industries Machines	742	425	0.05
Office, Computing, Actg. Mach.	5,023	2,750	0.35
Electric Industrial Equipment	1,054	669	0.08
Radio, TV, Comm. Equipment	13,722	7,812	0.98
Electronic Components & Acces.	1,435	3,643	0.44
Misc. Electrical Machinery	195	111	0.01
Scientific & Control Instruments	2,187	1,851	0.23
Optical, Ophthalmic, Photographic Equipment	2,550	2,453	0.31
Imports	-1,618	---	
<u>TOTAL MANUFACTURING DURABLE INFORMATION GOODS</u>	<u>25,290</u>	<u>20,987</u>	<u>2.64</u>
<u>Construction: Information Structures</u>			
New Construction (Offices)	11,840	6,307	0.79
Maintenance and Repair Construction (Offices)	1,423	3,710	0.47
<u>TOTAL CONSTRUCTION: INFORMATION STRUCTURES</u>	<u>13,263</u>	<u>10,107</u>	<u>1.27</u>

The private and public bureaucracies are largely substitutable. They both operate in a world of rule-making and standardized procedures. They are virtual monopolists of certain kinds of information, yet they are seldom regulated nor do they compete in the traditional sense for their "revenue". These bureaucracies can be conceived as firms from an accounting standpoint also, and the following two sections will describe the share of GNP attributable to these "firms".

In sum, the private bureaucracies cost us \$141 billion to maintain -- some 17 percent of the 1967 GNP. The public bureaucracies cost us an additional \$65 billion, or another 8 percent of GNP. That is, fully one fourth of the 1967 economy is accountable purely to the informational activities of the private and public planning systems. Let us see how these numbers were developed.

The Public Bureaucracy

Governments perform many functions, some of which are purely informational in nature. In this section we shall take a close look at the informational inputs and outputs of the Federal government -- the largest information industry in the U.S. economy.

The Federal information industry can be conceptually described as a multi-product firm, with a definable stream

of inputs and outputs.⁸ The "marketplace" in which the "firm" operates is drawn in Figure 3. Demand for the firm's outputs originates with voters or special interests expressed directly in the form of lobbying or indirectly through the voting mechanism. In response to these preferences, budget -- the government's bill of goods and services to be purchased -- is formulated by the President and reformulated by Congress. The budget represents the firm's obligations to purchase goods and services from the private economy and to hire labor services from households. Table 5 shows an overview of the government's inputs in 1967, and Table 6 shows a detailed breakdown of those inputs. The government purchased two classes of goods and services, as shown in Figure 3. The informational inputs -- such as computers, communication gear, filing cabinets, R&D services, office space, satellites, managers, clerks, scientists, lawyers, economists -- accounted for over \$44 billion out of a \$91 billion procurement. In addition to these direct purchases, the Federal Government "bought" educational services from state and local governments through grants-in-aid and transfers.

⁸For a discussion on the economics of bureaucracies, see William A. Niskanen, Jr., Bureaucracy and Representative Government, Aldine-Atherton, Chicago, 1971.

FIGURE 3: THE FEDERAL "INFORMATION INDUSTRY" - INPUTS & OUTPUTS

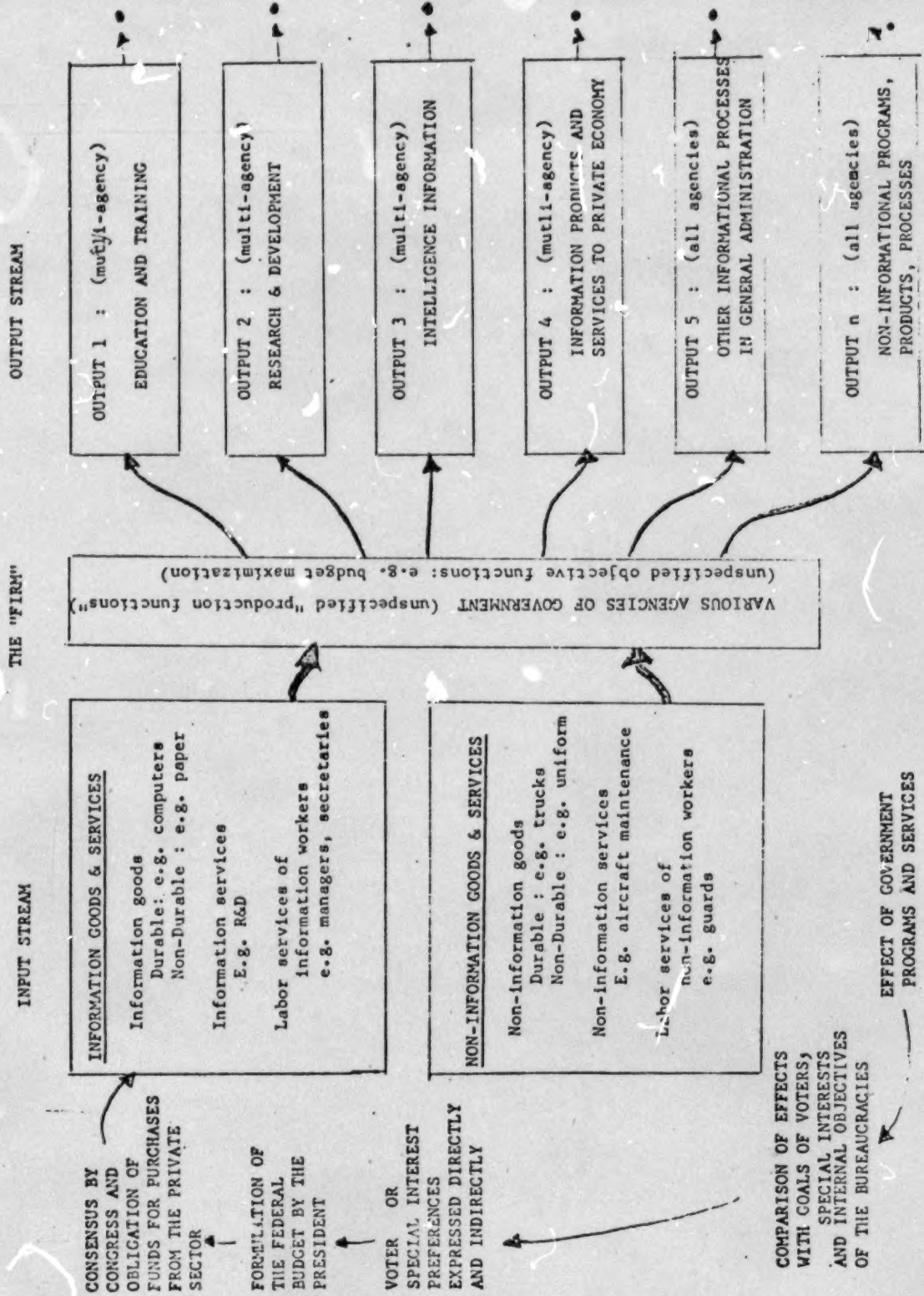


TABLE 5: INFORMATIONAL INPUTS OF THE FEDERAL GOVERNMENT
(\$ Millions 1967)

	TOTAL	INFORMATION	NON-INFORMATION
TOTAL EXPENDITURES	163,594	60,873	102,721
PURCHASES OF GOODS & SERVICES FROM THE PRIVATE SECTOR	<u>90,706</u>	<u>44,926</u>	
Information goods		8,826	
Information services		2,982	
Research & development		13,133	
Non-information goods and services		--	
Wages & salaries	35,205	--	--
Information workers		20,028	--
Non-information workers			15,177
"PURCHASES" FROM STATE & LOCAL GOVERNMENT AS GRANTS	<u>15,826</u>	<u>3,011</u>	<u>12,815</u>
Educational services		2,924	
Other informational S.		87	
Non-informational			12,815
"PURCHASES" FROM TRANSFER ACCOUNTS & OTHER FINANCIAL ACCOUNTS	<u>52,417</u>	<u>12,954</u>	<u>39,463</u>
Debt service payments for general administration		10,456	
Other informational		2,498	
Non-informational (e.g., social security & welfare payments)			39,463
SUBSIDIES LESS CURRENT SURPLUS OF GOVERNMENT ENTERPRISES	<u>4,645</u>	<u>-61</u>	

Source: Department of Commerce, U. S. National Income and Product Accounts, SCB; unpublished data: details of government purchases from the private sector, BEA; Industry by Occupation Wage matrix, unpublished data based on BLS and BLS data; Civil Service Commission report "Occupations of Federal White Collar Employees;" Census of Manufacturers and Census of Business for 1967.

(\$ Millions, 1967)

23

These factor inputs enter the firm's production function in some unspecified manner. That is, the firm chooses a mix of capital and labor that maximizes its return in the provision of outputs according to some objective function. What that objective might be has been the source of considerable debate recently. Some people think that the agencies' objective is to maximize budget; others claim that the individual bureaucrat's objective is to minimize risk; in an elective context, the objective is clearly to maximize votes. A possible objective might even be to maximize social welfare. The particular choice of production and objective functions does not change our accounting scheme.

The inputs are transformed into a variety of outputs, which are sold to consumers and presumably generate some level of satisfaction or well-being. The value of the outputs is not known in a conventional sense; since consumers (voters) reveal their preferences only in a diffused manner -- through the long delay loop associated with representative government and election. However, one can break down the government's outputs into a fairly coherent scheme. We are now working to break down the government's outputs into a fine level of detail. The intention is to replicate the primary information sector industries within the government as much as possible. For example, like the primary informational sector, the Federal bureaucracy contains an "accounting industry" (GAO), a "printing industry" (GPO), an "insurance industry" (FDIC), an "employment

agency" (Civil Service Commission), and a "library industry" (Library of Congress, National Library of Medicine). In addition, there are a number of outputs which have only weak analogs in the private economy -- regulation, foreign intelligence, economic planning -- and are more closely related to the "quasi-firms" of the secondary sector.

Table 7 shows the outputs of the Federal Government arranged into three classes: (i) outputs that have direct analogs in the primary information sector; (ii) the "secondary" outputs; and (iii) specialized government functions. We are now analyzing the Federal Budget (1958-1972) to measure the growth of these governmental industries.

By assumption, the entire bill of goods purchased as information inputs is consumed in the provision of the information outputs. In this manner, we can impute a price to each of the services as equalling the cost of inputs.

TABLE 7: PRIMARY & SECONDARY INDUSTRY OUTPUTS OF THE FEDERAL GOVERNMENT (Plus Examples)

I. PRIMARY INDUSTRIES

A. Management Consulting

Office of Management and Budget
Soil Conservation Service
National Mediation Board
Institute for Telecommunication Sciences

B. Physicians Offices (prorated)

Center for Disease Control
U.S. Army Health Services Command
Veterans Administration (part)

C. Accounting

General Accounting Office
Defense Contract Audit Agency
Comptroller of the Army

D. Financial

1. Loans and Credit

Rural Electrification Administration
Maritime Administration
Housing and Urban Development Mortgage

2. Currency

Bureau of the Public Debt
Federal Reserve System (part)

E. Data Processing

NIN, Justice, Treasury - general purpose computers
Internal computation sections

F. Telecommunications

Defense Communications Agency
GSA Automatic Data and Telephone Service
ARPANET

G. Insurance

Social Security Administration
Federal Crop Insurance Corporation
Overseas Private Investment Corporation

H. Publishing

Bureau of Engraving and Printing
Government Printing Office
National Technical Information Service

I. Real Estate Management

GSA Public Building Service
Federal Property Council

J. Libraries

Library of Congress
National Library of Medicine
National Archives

K. News and Broadcasting

1. News Syndicates

U.S. Information Agency
Voice of America
Corporation for Public Broadcasting

2. Public Relations and Advertising

U.S. Travel Service

L. Education

Agricultural Extension Service
Transfer payments for education
U.S. Naval Academy

M. Research and Development

National Bureau of Standards
U.S. Geological Survey
Director of Defense Research and Engineering
NSF, NRC, etc.

N. Legal

The Federal Courts
The General Counsels
The Department of Justice (portions)

O. Employment Agencies

Civil Service Commission
Selective Service System
U.S. Army Recruiting Command
Agency personnel offices

II. "Secondary" Industries

P. Policy Planning

The Congress
The President and the White House Staff
The Joint Staff (DOD)
Cabinet Level Administrators
Health Resources Administration

Q. Market Information Specialists

Foreign Agricultural Service
Defense Supply Agency
Federal Supply Service

R. General Administration

(residual includes many components not subject to breakdown)

1. Variety of quasi-industries mirroring the primary industries above.

III. Specialized Governmental Functions

S. Intelligence

1. Foreign

CIA
Defense Intelligence Agency
National Security Agency
National Reconnaissance Office

2. Domestic

FBI
Drug Enforcement Agency
Defense Investigative Service
Secret Service

T. Regulation of Industry

Nuclear Regulatory Agency
Civil Aeronautics Board
Securities and Exchange Commission
Antitrust Division of Justice Department
Comptroller of the Currency
Occupational Safety and Health Administration

U. Economic Planning Information

Internal Revenue Service
Bureau of Labor Statistics
Federal Crop Reporting Service
Bureau of Economic Analysis

V. Diplomacy and Foreign Policy

National Security Council
Department of State (excluding AID transfer payments)
International Trade Commission
Arm. Control and Disarmament Agency

W. Services Provided Free to Private Industry

Federal Aviation Administration
Coast Guard (Harbor Management and Regulation;
Safety Inspections)

The Private Bureaucracy

The private economy has an information bureaucracy of its own. This is the planning, coordination and management sector that exists in every organization -- a collective of decision-makers and paper shufflers, of inventors and designers, of information machine operators. It is the corporate army of (technically) "non-productive" workers who earned a staggering \$162,644 million in wages and salaries in 1967, and whose activities accounted for around 20 percent of value added.

These bureaucratic empires can be divided into smaller firms-within-firms. One can build, in an accounting sense, a "data processing firm" within a pharmaceutical company; or a "law firm" within a steel manufacturer.

Table 8 shows a partial list of these "quasi-firms" -- firms that produce an information service which is completely consumed by the non-information firm. By assumption the services of the quasi-firms are "sold" to the non-information side of the firm. The value of these services is then embedded as a joint output with some non-informational good or service. For example, a ton of steel may contain 18¢ worth of "information services" that were produced by the steel firm's quasi-firms.

TABLE 8 PARTIAL LIST OF QUASI-FIRMS WITHIN NON-INFORMATION FIRMS

QUASI-INDUSTRY	INPUTS	OUTPUTS
Electronic data processing services	Computer hardware, perfirals, programing, consulting	EDP services, e.g., accounting, payroll, inventory, MIS
Advertising	Services of writers, artists, account mgrs, office and other facilities; photo-composing and art equipment; video and film equipment	Placing time in media, producing advertisements, designing adv. campaigns
Letter typing service	Secretaries, typewriters, composers, stationary, desks, office space...	Letters, business communications
Duplicating service	Xerox machines, operators, paper, operators	Copies
Printing service	Printing presses, folding and binding equipment, platemaking equipment, pressmen, operatives	Firm's stationary, forms, brochures etc. not contracted from the outside
Direct Mail Service	Addressographs, computer files, labeling & stamping machines, paper and envelopes, operators, facilities	Addressing service, mailing mailing service, mailing list management etc.
Research & Develop.	Laboratories, EDP, scientists, technicians, support staff, facili.	R&D knowledge, invention, patents, processes, evaluations
Press Clipping Svc.	Newspapers, clerks, facilities	Newsletter -- customized information service.
Business Management	Services of managers, telecommunications, EDP, facilities, support staff, consulting economists, technicians, scientists, marketing	Planning
Accounting & Bookkeeping services	Services of accountants, bookkeepers, supporting clerical staff, accounting machinery, EDP, telecommunication facil.	Accounting information, billing etc.
Legal services	Attorneys, facilities, telecommunication, EDP, supporting clerical staff and facilities	Counsel, litigation, letters, briefs, etc.
Patent and Copyright Holding	Knowledge products, e.g., books, records, inventions	Royalty income
Library Services	Books, filing cabinets, shelves, librarians	Information sotrage and retrieval services, research services

Table 9 shows an analysis of the employee compensation paid by non-information industries. (These industries have been "cleaned" to remove the informational components). A quick glance at the ratios of information wages to total wages shows that a significant portion of a non-information firm's values added originates in the provision of information services. A similar breakdown was computed on the capital flow matrix to show the depreciation (capital consumption allowances) taken on information machines vs. non-information machines. Together, these two items completely account the flow of both labor and capital services -- hence the value added in the private bureaucracies.

Information Flows Between the Planning Sectors

These two bureaucracies "talk" to each other, more or less effectively, in coordinating and managing our entire economy. Their communications instruments are well known: the telephone, the computer, the telecommunications network, the omnipresent memos, letters and forms. The amount of paperwork flowing into Federal agencies each year has been estimated to fill 4 1/2 million cubic feet of space. The Select Committee on Small Business, in a report on "The Federal Paperwork Burden" estimated that

Table 9 COMPONENTS OF VALUE ADDED ORIGINATING IN THE SECONDARY INFORMATION SECTOR

Non-Information Industry	Employee Com- pensation of Info. Workers	Info. as % of Compen- sation	Capital Con- sumption Allowances (Depreciation on Info. Capital)	Info. as % of Total Depreciation	Total Secondary Value Added
(\$ Millions 1967)					
1) Livestock & Products	24	1.98	18.6	.32	67
2) Other Agriculture Products	43				
3) Forestry & Fishery Prods.	24	21.42	6.0	9.61	30
4) Agr., Forest, Fish Services	166	23.12	7.1	3.71	173
5) Iron, Ores, Mining	65	27.38	1.6	2.50	71
6) Nonferrous Ores Mining	116	27.42	1.4	2.12	117
7) Coal Mining	179	14.47	3.3	1.38	183
8) Crude Petrol, Natural Gas	481	54.54	50.9	2.26	532
9) Chemicals Mining	33	29.57	2.6	1.42	53
10) Stone, Clay Mining	217	29.60	7.3	2.54	224
11) New Construction, Net	7073	33.09	261.6	12.39	9949
12) Mainten & Repair Constr., Net	2614				
13) Ordnance & Accessories	2652	64.73	23.0	23.73	2675
14) Food & Kindred Products	4571	34.65	178.1	10.79	4749
15) Tobacco Manufactures	247	40.96	6.0	8.17	253
16) Fabrics, Yarn & Thread	1018	30.07	18.3	4.63	1036
17) Misc Textile Goods	312	39.39	5.0	6.63	317
18) Apparel	2185	32.10	40.0	18.62	2225
19) Misc Fabricated Textiles	345	38.25	5.2	13.59	350
20) Lumber & Wood Products	827	26.82	19.2	4.04	846
21) Wooden Containers	50	32.66	0.9	6.42	51
22) Household Furniture	539	32.70	5.8	7.36	545
23) Furniture & Fixtures, Net	180	32.09	4.4	9.84	184
24) Paper Products, Exc Boxes, Net	1145	40.42	339.9	41.51	1485
25) Paper Contain & Boxes	726	43.29	5.1	3.49	731
26) Printing & Publishing, Net	514	83.31	N/A	N/A	514
27) Chemicals, Net	2212	52.79	100.5	8.36	2313
28) Plastics & Synthetics	854	43.00	40.8	8.10	895
29) Drugs, Cleaning & Toilet	1579	64.16	36.4	0.31	1615
30) Paints	380	59.10	14.0	25.40	394
31) Petroleum Refining	1273	56.18	62.7	6.51	1336
32) Rubber & Plastics	1652	41.24	27.1	6.51	1679
33) Leather Products	60	25.64	1.3	7.92	61
34) Leather, Industrial	436	29.48	4.9	12.83	441
35) Glass Products	554	39.18	13.7	7.62	568
36) Stone & Clay Products	1345	39.78	50.5	8.01	1396
37) Primary Iron & Steel Mfg.	2843	30.98	125.7	6.55	4068
38) Primary Nonferrous Mfg.	1312	38.00	48.3	7.41	1360
39) Metal Containers	315	41.83	6.0	6.75	321
40) Heating & Plumbing Prods.	1475	42.92	29.0	13.29	1765
41) Screw Machine Prods.	1183	38.42	19.2	7.08	1202
42) Other Fabric Metal Prods.	1535	42.33	20.4	8.03	1555
43) Engines & Turbines	468	46.61	12.1	9.07	480
44) Farm Machinery	550	44.04	14.8	11.73	565
45) Construction Machinery	823	47.65	29.7	13.17	853
46) Material Hauling Machinery	376	47.66	12.9	21.69	389
47) Metalworking Machinery	1437	43.66	50.3	15.12	1487
48) Special Industry Mach., Net	733	46.83	20.3	11.09	753
49) General Industry Machinery	1203	46.81	46.2	15.54	1249
50) Machine Shop Prods.	766	46.82	2.4	5.27	768
51) Service Industry Machines	539	46.83	16.3	15.20	555
52) Electrical Ind. Apparatus, Net	1498	52.97	73.3	28.93	1571
53) Household Appliances	539	40.07	34.2	27.63	573
54) Electric Light & Wire	636	53.00	22.0	21.22	656
55) Misc Electric Prods., Net	478	52.93	N/A	N/A	478
56) Motor Vehicles & Equip.	2970	35.14	144.5	13.08	3115
57) Aircraft & Parts	5079	59.23	99.1	20.40	5178
58) Other Transport. Equip.	887	35.62	28.4	16.59	915
59) Prof. & Sci. Equip., Net	268	47.26	44.3	24.59	312
60) Optical & Photo. Equip., Net	70	50.36	36.8	18.78	107
61) Transport. & Warehouse	7277	34.77	388.0	8.21	7665
62) Utilities	1983	49.52	149.6	4.09	2033
63) Wholesale & Retail, Net	32,289	53.54	870.6	13.12	33,160
64) Finance & Insurance, Net	469	97.51	1147.3	80.05	1616
65) Real Estate & Rental, Net	1474	96.53	349.4	2.07	1823
66) Hotels, Personal, Repair, Net.	1781	27.05	118.8	8.20	1900
67) Misc Business Services, Net	2837	84.54	839.6	59.54	3677
68) Auto Repair & Service	1073	28.35	27.0	2.82	1100
69) Amusements, Net	505	35.84	114.7	18.53	620
70) Medical & Nonprofit, Net	4333	38.29	180.6	27.70	4514
71) Fed. Gov't. Enterprise, Net	1335	79.85	N/A	N/A	1335
72) State & local Gov't.	1441	69.61	N/A	N/A	1441

TOTAL

\$ 129,222 M

"it's costing about \$18 billion a year at all levels of Government to print, shuffle, and sort all these forms. It is also costing small businessmen about \$18 billion to fill out the different forms, Internal Revenue Service forms, wage and price forms, social security forms, quarterly this and monthly that. And the cost of the small businessman must necessarily be passed to you and me, to the consumer."

Senator McIntyre's summary
(Page 2)

The 7 volume, 2,285 page report only discusses small business. One can only gasp at the additional paper shuffling of larger enterprises, and the total cost to us both as consumers and taxpayers. For example, the office of the Secretary of Defense has estimated that the cost of producing and distributing user's manuals on DoD weapons systems alone ran over \$4 billion in 1972!

THE SIX SECTOR ECONOMY

The structure of the three information sectors, and their relation to the rest of the economy, is shown in Figure 4.

The primary information sector produces, processes and distributes information goods and services for sale to the rest of the economy. Its major input, other than the goods and services purchased endogenously, is information labor from the household sector. Its outputs -- computers, radios and TV's, newspapers, accounting services, R&D and the like -- are purchased by households, by the private and public bureaucracies and by other primary information industries.

Sector II, the private bureaucracy, includes all the planning, inquiring, communicating and decision-making capabilities in the private sector. It houses the white collar superstructure that controls the manufacturing and distributive activities of the modern corporation. It draws as its major inputs the goods and services produced by the primary information sector (e.g., telecommunications, computers and information workers from households), and has three kinds of outputs: (i) the private bureaucracy performs information services on behalf of the "productive" sector; (ii) it communicates with the public bureaucracy through required tax and business information giving and through private lobbying; (iii) it communicates with households through advertising and market information programs.

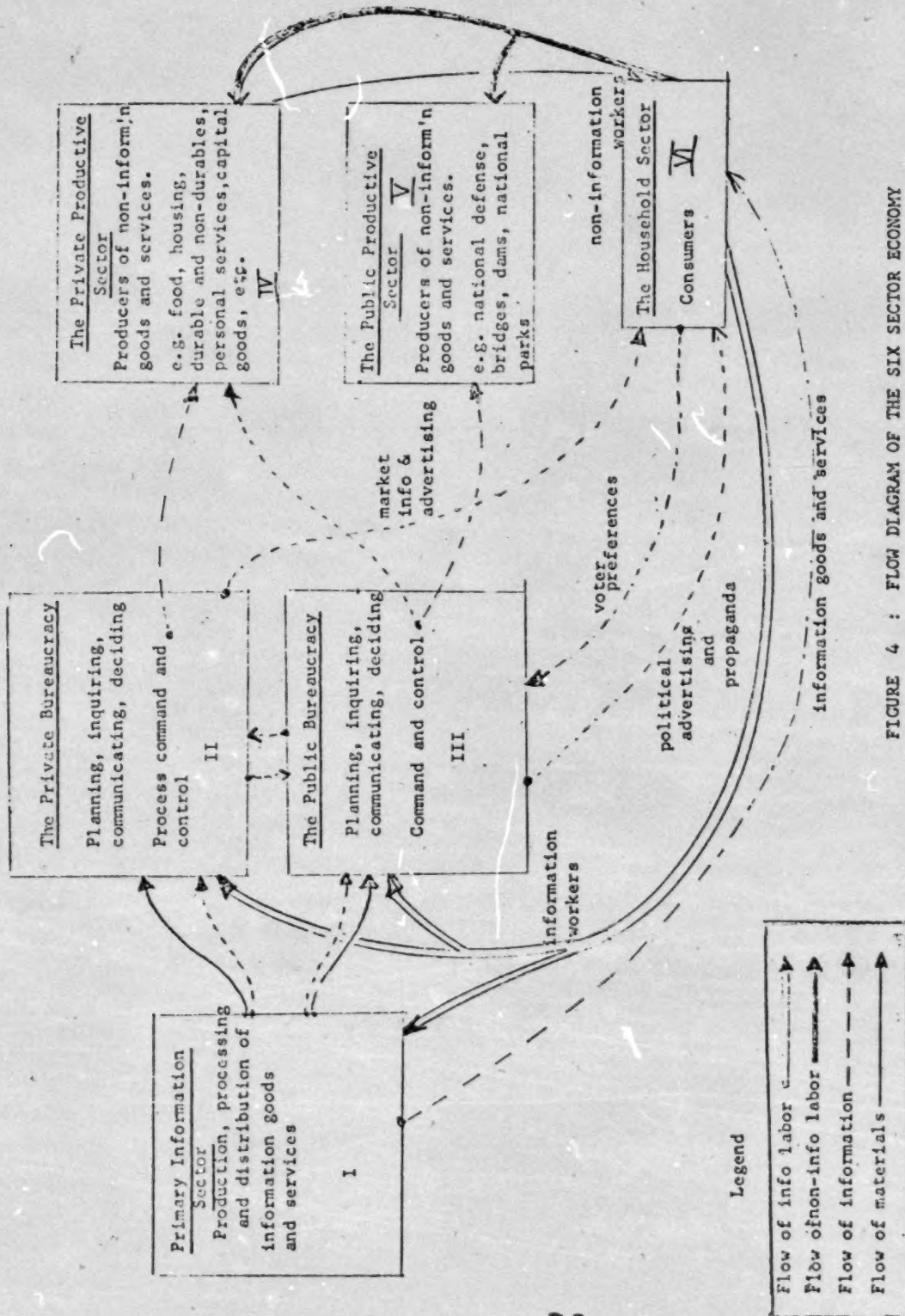


FIGURE 4 : FLOW DIAGRAM OF THE SIX SECTOR ECONOMY

Sector III, the public bureaucracy, performs the planning and decision-making activities of the government agencies. Some actions may constitute direct market intervention (e.g. regulation), other actions may affect market allocations indirectly (e.g. tax and subsidy programs, personal income redistribution). Its major inputs include goods and services purchased from the primary information sector (e.g., office buildings, computers, consulting) plus information workers from the household sector (e.g., managers, secretaries, computer programmers). Its major outputs are a variety of informational services, plus process command and control of a few "productive" activities (e.g., dam-building). It receives voter preference or special interest information as a major input, and puts out a variety of political information and propaganda messages as outputs.

Finally, we see the household sector, which supplies labor services to the primary information sector, to the public and private bureaucracies and to the private and public "productive" sectors. It buys goods and services from the primary information sector (e.g., pocket calculators, financial transaction services, movies), and a large variety of goods from the private productive sector (e.g., food, housing, clothing). The household sector puts out preference information to the private bureaucracy (through allocation of disposable income) and to the public bureaucracy (through the voter lobby).

The Input-Output Matrix

The conceptual scheme in Figure 4 shows the flow of goods and services between the six sectors of the economy. In reality, the flow of goods and services to intermediate and final demand is a highly complex transaction. To summarize the interrelated nature of the U.S. economy, I have translated the six-sector scheme into an Input-Output matrix. The work was done at a very fine level of detail (at the 7-digit Standard Industrial Classification Code level) with the help of the Bureau of Economic Analysis which is responsible for producing both the National Income and Product Accounts and the Input-Output tables.⁹

Table 10 shows a simplified summary of the revised Input-Output matrix. A word of explanation is in order. The major sectors displayed along the top of the transactions table represent the consuming industries, and the sectors on the left side of the matrix are the producing industries. Since all industries both buy and sell goods and services, the transactions table shows the inter-industry sales. For example, the primary information industries sold \$62.4 billion within the sector, and another \$75.4 billion to the information "quasi-industries" within non-information firms. To repeat, the actual I/O tables show these flows of goods and services in great structural detail.

⁹Our software can produce any I-O matrix of any dimension up to the 507 order level.

CONSUMING INDUSTRIES

PRODUCING INDUSTRIES	PRIMARY INFORMATION SECTOR	SECONDARY INFORMATION SECTOR	NON-INFORMATION SECTOR	FINAL DEMAND
PRIMARY INFORMATION SECTOR	\$62.4	\$76.5	0	\$131.6 16.5%
SECONDARY INFORMATION SECTOR	0	\$1.5	\$218.7	45.3 5.7%
NON-INFORMATION SECTOR	\$53.8	0	\$526.9	618.5 77.7%
VALUE ADDED	\$152.6 20.4%	\$199.6 25.1%	\$433.2 54.5%	GNP = \$795.4

TABLE 10 : 1967 INPUT - OUTPUT MATRIX
(\$ Billion current)

The intermediate flows within the large square matrix should not be confused with the final demand flows on the right hand column. As shown, the secondary information sector by assumption has no output other than the employee compensation of government information workers. The entire output of the private bureaucracies (some \$218.7 billion) is sold on a fictional account to the non-information side of the firm. Also, the intermediate sales should not be confused with the value added row at the bottom of the matrix.

When the matrix is completed later this year, we shall be in position to address a large number of policy questions regarding the structure of the information economy. Table 11 gives a flavor of the types of questions that are appropriate for Input-Output analysis.¹⁰

¹⁰ See generally: Brody and Carter (eds.), Input-Output Techniques, North-Holland Publishing Co., New York 1972.

William Miernyk, Elements of Input-Output Analysis, Random House, New York, 1965.

Chiou-Shuang Yan, Introduction to Input-Output Economics, Holt, Rinehart & Winston, 1969

TABLE 11:USES OF THE INPUT-OUTPUT MATRIX

- (i) Estimating the direct plus indirect effects on GNP and on the distribution of GNP across industries given a change in final demand, such as:
 - A change in gross capital formation (investment) in a particular type of capital good, e.g., a telecommunication network.
 - A change in exports or imports, e.g., royalty and patent imports and exports, tariff changes.
 - A change in government purchase of goods and services, e.g., procurement alternatives.
 - A change in personal consumption expenditures.
- (ii) Estimating the direct plus indirect effects on labor given a change in the output of a given industry. This involves a detailed labor impact analysis of a change in final demand. The same methodology can be adapted to investigate the effect on GNP and the workforce under different assumptions regarding productivity.
- (iii) Estimating the effect on GNP and prices given a change in one of the factor prices, i.e., in wages (due to unionization of the white-collar or "information" workers), capital (due to capital shortages or riskiness in high technology enterprises), or natural resources. In conjunction with this application, a technique for decomposing inflation by industry source has been developed in the U.S. An open research question is whether the information sector is inflationary (due to high labor requirements and lack of an adequate productivity measure) or deflationary (due to the extensive use of cost-declining technology and the sparse use of cost-rising energy resources).
- (iv) Revealing the structural interdependence of the economy with respect to the "information infrastructure." In particular, investigating possible "bottlenecks" in the economy as investment or development programs are undertaken. A closely related application is to measure the effect of a constraint on an investment or development program, e.g., imposing the constraint of zero growth in energy consumption.
- (v) Estimating the effect of technical substitution on the economy. For example, forecasts of information-intensive production functions (i.e., high degree of substitution of computer technology for mechanical or labor-intensive technologies) can be implemented experimentally in the I-O matrix to gauge the change in requirements -- both direct and indirect -- on the rest of the economy.

CLOSING STATEMENTS

The work reported in this paper is directed towards building a sufficiently robust "soapbox" so that policy makers in the field of communications can move past the debate whether or not we are in fact an emerging information economy. Time series data will confirm that the trends are persistent, continuous and probably irreversible. The interrelated structure of the information sectors to the rest of the economy and within itself is now apparent and measurable.

We have seen that the information activity in the U.S. economy accounted in 1967 for over 45 percent of Gross National Product. By now, some nine years later, the activity is probably approaching 50 percent of GNP. Half of our wealth originates with the provision of a myriad of information goods and services; and half of that originates in the planning sectors of the economy.

Yet, despite the enormous commitment of resources to this information creature, our self-image has not substantially changed. We still see ourselves as an industrial society, composed of firms engaged in vigorous competition on open marketplaces. We still hold that markets, if left to their own competitive devices, will find some benign equilibrium that efficiently and equitably allocates resources. We still persist in denying what has become awesomely plain to see: that we

are already a planned economy. The planning sector is growing by leaps and bounds both inside the private and public bureaucracies. Our schools and universities are churning out the planning work force every year -- administrators, managers, analysts, information scientists. Together they own and control a brand new technology, something that has never existed in such abundance before. They control a soft technology -- theory, methodology, organizational and technical knowledge, practical experience to create almost anything imaginable. And they control a hard technology -- computers, satellites, a communication infrastructure to help them inquire, plan, decide, order, monitor and evaluate their planning efforts.

The question is not whether we want to plan or not. The question is how to use our planning resources so that the planning that is being done will be done most productively. In the American context, I believe that this means something very specific. It is not the French version of indicative planning; it is not the Japanese plan of central bank control; it is not the Russian five year command economy; it is not the Chinese communal planning. We need to plan for market structures that, once in place, require very little planning and control. This is not a trick phrase spun of rhetoric. Rather, it is a challenge to invent some institutional mechanism to coordinate the entrepreneurial initiative of firms and the intent of ...

policy-makers in a manner that is consistent with some stated social good.

The force of technological change has a way of both creating and destroying markets. As technology progresses, old institutions come into direct conflict, and new ones form to mediate the conflicts or appropriate the profits that the new opportunities present. The advent of an information economy puts us in a refreshing and rare position. We can pari passu observe, define and measure the economy as it develops.

Epochal social and economic changes are seldom discrete events. Rather, they emerge slowly -- first as changes in the technological or economic organization of a society. Later, maybe much later, after changes in the infrastructure have matured, social organization responds at the level of the superstructure. Legal organization, social organizations, rules and habits, and finally behavior slowly but surely adjust. The role of policy, it seems to me, is to embed an ideology -- a sense of what "ought to be", a normative idealism -- into emerging infrastructures.

But it is not clear to me how a planning environment that fosters a secretive and ultra-adversary relationship between the private and public bureaucracies is likely to result in meaningful long-range development of the information economy. And it is clear that without such planning, the many pitfalls and dead-ends associated with rapid development of a new technology and a new economic order will not easily be avoided.

In the case of the information economy, the policy opportunities are ample and well-known. Research efforts at Stanford, Harvard, M.I.T. and other schools with programs on information technology and public policy are beginning to form images of "desirables" and "undesirables". New firms are crowding the competitive edge of traditionally monopolized industries, clamoring for new rules that will allow them entry. And the Washington machinery is besieged by policy issues whose higher-order consequences have hardly been conceived.

These events are so abstract and impersonal that they have not yet entered the public consciousness. It is a great irony that when crucial social policy is set into place, only the elite -- in business, government and academia -- has any incentive to intervene.